post_incompact3d

We collect here discretized versions of flow statistics and parameters implemented for post-processing for a temporal TBL in the program `post_incompact3d`. For integral quantities, use the python function `high_order_integrals.py` (same parent directory). It is possible to compile the program with `TTBL_MODE=OFF`, in order to perform the averages also in time (it can be used for example for channel flow simulations). Compilation is made with `cmake` as the solver. It is possible to specify the compilation option `Channel mode` in the following manner:

```
cmake -DTTBL_MODE=OFF ../
```

since the `TTBL mode` is the default one.

If a specific compiler needs to be specified, the full command is:

```
cmake -DTTBL_MODE=OFF -DCMAKE_Fortran_COMPILER=gfortran ../
```

For further details, see the quick guide for the Incompact3d solver.

Statistics are averaged along x and z directions. Different flow realizations can also be considered. Average in time is performed only with `TTBL_MODE=OFF`, that is a parameter that can be changed inside the `build` directory, inside the `CMakeCache.txt` file (used for the compilation with `cmake`).

Velocity field (O(6))

- Averages

$$\langle u \rangle, \langle v \rangle, \langle w \rangle$$

- Variances

$$\langle u'^2 \rangle, \langle v'^2 \rangle, \langle w'^2 \rangle$$

- Skewnesses

$$\mathsf{skew}[u], \mathsf{skew}[v], \mathsf{skew}[w]$$

- Kurtoses

$$\mathsf{kurt}[u], \mathsf{kurt}[v], \mathsf{kurt}[w]$$

Reynolds stresses (O(6))

$$\langle u'v' \rangle, \langle u'w' \rangle, \langle v'w' \rangle$$

Pressure field (O(6))

- Average and variance

$$\langle p \rangle, \langle p'^2 \rangle$$

Scalar field (O(6))

- Average and variance

$$\langle \varphi \rangle, \langle \varphi'^2 \rangle$$

Mixed fluctuations (O(6))

$$\langle u'\varphi' \rangle, \langle v'\varphi' \rangle, \langle w'\varphi' \rangle$$

Vorticity field (O(6))

- Averages

$$\langle \omega_x \rangle, \langle \omega_y \rangle, \langle \omega_z \rangle$$

Mean gradients (O(6))

- Mean total parallel gradient (to the wall)

$$\langle \sqrt{\left(\frac{\partial u}{\partial y}\right)^2 + \left(\frac{\partial w}{\partial y}\right)^2} \rangle = \frac{\partial U_{\parallel}}{\partial y}$$

- Mean streamwise gradient

$$\langle \frac{\partial u}{\partial y} \rangle = \frac{\partial U}{\partial y}$$

- Mean spanwise gradient

$$\langle \frac{\partial w}{\partial y} \rangle = \frac{\partial W}{\partial y}$$

Total dissipation rate (O(6))

- Average

$$\langle \varepsilon \rangle = 2\nu \langle S_{ij} S_{ij} \rangle$$

where double contraction on the indexes i and j is performed.

Correlation functions

At the moment, the only (auto) correlation function implemented is the one for the streamwise velocity fluctuations, as function of the spanwise separation variable r_z. Moreover, it is calculated only with `TTBL_MODE=ON`.

$$R_{uu}(r_z) = \langle u'(x, y, z + r_z, t) u'(x, y, z, t) \rangle$$

For the channel flow case, re-opening of the mean velocity field is required to calculate the complete fluctuations (to be done).